

**AMENDMENTS TO THE DRAWINGS:**

The attached Replacement Sheet includes changes to Figure 1. This sheet replaces the original sheet containing Figure 1. No new matter has been added.

## REMARKS

This Preliminary Amendment cancels, without prejudice, claims 1-12 in the underlying PCT Application No. PCT/DE2004/001623 and adds new claims 13-24. The new claims, *inter alia*, conform the claims to United States Patent and Trademark Office rules and do not add any new matter to the application.

In accordance with 37 C.F.R. § 1.125(b), the Substitute Specification (including the Abstract) contains no new matter. The amendments reflected in the Substitute Specification (including Abstract) are to conform the Specification and Abstract to United States Patent and Trademark Office rules or to correct informalities. As required by 37 C.F.R. §§ 1.121(b)(3)(ii) and 1.125(c), a Marked-Up Version of the Substitute Specification comparing the Specification of record and the Substitute Specification also accompanies this Preliminary Amendment. Approval and entry of the Substitute Specification (including Abstract) are respectfully requested.

The underlying PCT Application No. PCT/DE2004/001623 includes an International Search Report, dated November 24, 2004, a copy of which is included. The Search Report includes a list of documents that were considered by the Examiner in the underlying PCT application.

It is respectfully submitted that the subject matter of the present application is new, non-obvious, and useful. Prompt consideration and allowance of the application are respectfully requested.

Respectfully Submitted,

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METHOD AND DEVICE FOR WARNING THE DRIVER OF A MOTOR VEHICLE

FIELD OF THE INVENTION

The present invention relates to a method and a device for warning the driver of a motor vehicle, ~~an~~. An object detector ~~being~~is provided, which detects preceding vehicles and ascertains their 5 distance and relative velocity with respect to the host vehicle and supplies these to an evaluation device. The evaluation device assumes that the preceding vehicle would perform a deceleration and ascertains as a further function of the variables measured by the object detector and the driver's reaction time and the host 10 vehicle's maximum possible deceleration whether a collision with the preceding vehicle would be avoidable. If an unavoidability of a collision is recognized, then a driver warning device is activated.

15 Background Information

BACKGROUND INFORMATION

A haptic indicator for motor vehicles is ~~known from~~described in European Patent No. EP 0 348 691 A2, which in combination with a 20 proximity-warning device gives the driver an appropriate signal when a minimum distance with respect to the preceding vehicle is undershot. Vibrations of the vehicle or its parts such as the steering wheel or the driver's seat are provided as a haptic signal. The vibrations are caused for example by an intermittent 25 interruption of the ignition of the engine.

German Patent Application No. DE 198 57 992 shows a device for kinesthetically signaling the driver of a motor vehicle if in a system for controlling the travel velocity a shutdown is imminent 30 or has occurred, caused by a malfunction or intentionally, or if in a system for controlling the travel velocity a set maximum value

of the deceleration is not sufficient to avoid a collision of the controlled vehicle with a preceding vehicle or an obstacle, means being available, which modulate a brake setpoint value or a variable derived from it in such a way that the motor vehicle under 5 goes a deceleration fluctuating over time that is noticeable by the driver.

#### ~~Essence and Advantages of the Invention~~

##### 10 SUMMARY

~~The essence~~ In accordance with an example embodiment of the present invention ~~is to specify~~, a method and a device are provided for warning the driver of a motor vehicle, informing the driver as to whether, if the preceding vehicle were suddenly to brake with a 15 certain deceleration value, a collision of the host vehicle with the preceding vehicle would be avoidable or not. ~~The~~ An example method according to the present invention and ~~the~~ an example device according to the present invention accordingly informs the driver as to whether in the current driving situation, depending on the 20 distance, the relative velocity of the two vehicles, the host vehicle's absolute velocity as well the host vehicle's ability to decelerate and reaction time, a collision would be avoidable or a collision would not be avoidable in the event of a sudden deceleration of the preceding vehicle. ~~According to the present~~ 25 ~~invention, this is achieved by the features of the independent claims. Advantageous further developments and refinements are derived from the dependent claims.~~

Advantageously, the reaction time of the driver ~~is~~ may be determined 30 by averaging reaction times from previous driving situations in which a driver reaction was required.

It is furthermore advantageous ~~that~~ if the reaction time of the driver is a predetermined, fixed value.

35 It is furthermore advantageous ~~that~~ if the driver of the vehicle is personally able to specify the reaction time with the aid of a control element.

Advantageously, the driver warning is issued by an acoustic and/or visual signal.

5 Advantageously, the driver warning is issued by reversible belt tensioners in that these are pretensioned once or several times.

Furthermore it is advantageous that the driver warning is issued by a brief triggering of the deceleration meansdevice.

10 Furthermore it is advantageous that if the driver warning is issued by a haptic accelerator pedal. To this end there may be a provision for example to cause the accelerator pedal to vibrate with the aid of a vibration device or for the accelerator pedal to build up a 15 restoring force against the pedal pressure of the driver's foot in accordance with a specified setpoint value.

Furthermore it is advantageous that the driver warning is issued in the form of a vibration of the steering wheel. This may occur 20 with the aid of a vibration device attached to the vehicle's steering wheel, which when activated puts the steering wheel into a vibratory motion and thereby communicates a warning to the driver.

25 Advantageously, a visual and/or acoustic signaling device is provided as a driver warning device. For this purpose, the visual signaling device may be mounted in a display of the dashboard for example as a control lamp or as a plain text display. Furthermore it is possible to project the visual signaling devices with the 30 aid of a head-up display into the driver's field of vision. It is furthermore possible for the acoustic signaling device to be a warning sound or a textual output, which indicates the concrete reason for the warning by a voice output.

35 Furthermore it is advantageous to provide a reversible belt tensioner as a driver warning device. This reversible belt tensioner may be for example an electromotively operated belt

tensioner, which may repeatedly perform a tensioning of the belt, releasing the belt tension again at each turn.

5 In a particularly advantageous manner, the vehicle deceleration devices are may be provided as a driver warning device.

Particularly significant is the implementation of the The example method according to the present invention may be implemented in the form of a control element provided for a control unit of a 10 collision warning device of a motor vehicle. For this purpose, a program that is executable on a computer, in particular on a microprocessor or signal processor, and is suitable for implementing the method according to the present invention, is stored in the control element. In this case, the present invention 15 is thus implemented by a program stored in the control element such that this control element provided with the program represents the present invention in the same manner as the method which the program is suited to implement. In particular, an electrical storage medium, for example a read-only memory, may be used as a control element.

20 Additional features, applications and advantages of the present invention are derived from the following description of exemplary embodiments of the present invention, which are illustrated in the figures of the drawing. In this context, all of the described or 25 represented features, alone or in any combination, form the subject matter of the present invention, regardless of their combination in the patent claims or their antecedent reference, and regardless of their wording and representation in the specification and in the drawingsfigures, respectively.

30 Brief Description of the Drawing

#### BRIEF DESCRIPTION OF THE DRAWINGS

Exemplary embodiments of the present invention are explained below 35 with reference to the drawing. The figures show.

Figure 1 shows a schematic block diagram of specific embodiment of the device according to the present invention.

Figure 2 shows the mode of operation of a specific embodiment of the method according to the present invention.

## 5 ~~Description of Exemplary Embodiments~~

### DETAILED DESCRIPTION OF EXAMPLE EMBODIMENTS

Figure 1 shows an evaluation device 1, which, among other things, has an input circuit 2. Input signals can be supplied to evaluation device 1 via input circuit 2. As input signals, evaluation device 1 is supplied with, among other things, signals from an object detector 3, which may take the form for example of a radar sensor, a laser sensor, an ultrasonic sensor, a video sensor or of a combination of these sensor types. Object detector 3 ascertains for example the azimuth angle of preceding vehicles with respect to the extended vehicle longitudinal axis of host vehicle 12 and is thereby able to determine which detected object is the preceding vehicle 13. Furthermore, object detector 3 ascertains the distance  $d$  between host vehicle 12 and preceding vehicle 13 and the relative velocity  $V_{rel}$  of preceding vehicle 13 with respect to host vehicle 12 and supplies these measured variables to input circuit 2. In an advantageous manner, object detector 3 is mounted to the front side of the vehicle or in the area of the windshield and covers the space ahead of host vehicle 12 and is able to detect the objects located in the detection range. Furthermore, a velocity sensor 4 is provided, which determines the velocity  $V$  of host vehicle 12 and supplies it to input circuit 2. Velocity sensor 4 may be a specially provided velocity sensor, which measures, for example, the wheel speed, or a velocity sensor may be used, which is provided for example in connection with an anti-lock device or a driving dynamics control of vehicle 12. With the knowledge of the host vehicle's velocity  $V$  it is possible to convert the relative velocities  $V_{rel}$  ascertained by object detector 3 into absolute velocities. Furthermore, additional

input signal devices may be provided, for example control element 5, by which the driver is able to activate and deactivate the device according to the present invention or change settings of the device so as to adapt them to his requirements. The input 5 signals supplied to input circuit 2 are supplied via a data exchange device 6 to a computation device 7, which may take the form of a microprocessor or signal processor for example. From the input data supplied to computation device 7, the latter computes, in accordance with the method of the present invention, output 10 variables which are implemented by actuators downstream. The method according to the present invention may be contained in computation device 7 in the form of a control program. On the basis of velocity  $V_1$  of preceding vehicle 13 as well as a fictitiously assumed deceleration  $a_1$ , which in magnitude corresponds 15 approximately to an average vehicle deceleration, and by taking into account the distance  $d$  between the two vehicles and the velocity  $V_0$  of vehicle 12, and by taking into account a reaction time  $t_R$  of the driver, computation device 7 ascertains whether a collision would be unavoidable if vehicle 13 would indeed 20 implement deceleration  $a_1$  and if, following the elapse of reaction time  $t_R$ , a deceleration of host vehicle 12, which approximately corresponds to the maximum possible deceleration  $a_2$  of vehicle 12, were implemented, or whether it is not to be expected that host vehicle 12 will run into preceding vehicle 13 25 from behind. As a function of the result of the computation, computation device 7 emits a warning signal, which is supplied to output circuit 8 via data exchange device 6. Output circuit 8 transmits the warning signal to downstream warning devices 9, 10, 11, which convert this warning signal into a driver warning. 30 As a warning device, an acoustic and/or visual warning device may be provided for example. The visual warning device is, for example, a control lamp in the dashboard of the vehicle or a plain text display in a dashboard display which informs the driver about the reason for the warning. Furthermore it is also possible to project

the visual warning device in the form of a head-up display into the driver's field of vision. The acoustic warning device may be a signal sound, for example, which is output by a loudspeaker, or a voice output, which informs the driver about the reason for 5 the warning using a voice output. Alternatively or additionally, it is possible to use a reversible belt tensioner 10 as a warning device which informs only the driver or all occupants of the vehicle about the potential collision situation by a single or repeated pretensioning of the safety belt. It is likewise 10 possible, alternatively to the described warning devices 9, 10 or in combination or as an alternative to trigger deceleration device 11 of the vehicle briefly. A brief triggering of the vehicle's deceleration devices 11 warns the driver of the vehicle about the imminent possibility of collision by briefly 15 decelerating vehicle 12. In this respect, it is additionally possible to ascertain the coefficient of friction of the host vehicle during the brief deceleration of vehicle 12 and to use this ascertained coefficient of friction to adjust precisely an emergency braking action that may possibly be necessary later.

20 Figure 2 shows the operation of the method according to the present invention. On the left side, host vehicle 12 is shown at time  $t = 0$ , which has an object detector 3, and a preceding vehicle 13 is shown, which is traveling ahead of host vehicle 12 at a 25 distance of  $d = d_0$ . In this case, vehicle 13 moves forward at velocity  $V_1$  and host vehicle 12 follows the preceding vehicle at velocity  $V_0$ , which for activating a warning is necessarily greater than velocity  $V_1$  of preceding vehicle 13. Although preceding vehicle 13 is not decelerated, evaluation device 1 assumes for 30 calculating the risk of collision that preceding vehicle 13 is decelerated at the fictitious deceleration  $a_1 < 0$ . In a realistic case of a deceleration of preceding vehicle 13, reaction time  $t_R$  would elapse before the driver of host vehicle 12 would be able to implement a reaction. This is illustrated by the central

partial figure, which represents the precalculated scenario at time  $t = tR$ . Preceding vehicle 13 would continue to move at velocity  $V1$ , which would be lower, however, as a result of deceleration  $a1$ , than at time  $t = 0$ . Since during the time period between times  $t = 0$  and  $t = tR$  the driver of vehicle 12 due to the reaction time has not yet performed a vehicle intervention, host vehicle 12 continues to move at velocity  $V0$  as at time  $t = 0$ . This reduces the distance between the two vehicles from  $d = d0$  to  $d = d1$  during the time period between times  $t = 0$  and  $t = tR$ , as shown. Starting 5 at time  $t = tR$ , vehicle 12 also begins a deceleration  $a0$ , deceleration  $a0$  being quantitatively higher than deceleration  $a1$  of preceding vehicle 13. Since the preceding vehicle is decelerated at an average deceleration  $a1$ , but host vehicle 12 starting at time  $t = tR$  decelerates at a deceleration corresponding approximately 10 to the maximum possible vehicle deceleration, it may be assumed that  $a0 < a1$  since  $a0$  is quantitatively greater than the magnitude of  $a1$ . Furthermore, evaluation device 1 continues to compute, on the assumptions described, how the further braking maneuver will 15 end. For this purpose, the right partial diagram of Figure 2 shows time  $t = tR + tB$ , that is, the time following the elapse of reaction time  $tR$  and following the elapse of braking time  $tB$ . For this purpose one assumes that preceding vehicle 13 continues to brake at the constant fictitious deceleration  $a1$  and that as a result vehicle 13 at time  $t = tR + tB$  has a velocity  $V1$  that is lower 20 than the velocities  $V1$  at times  $t = 0$  or  $t = tR$ . During the braking time period  $tB$ , host vehicle 12 continued to be decelerated, the right partial figure showing the limiting case of a collision. In this connection, the limiting case is to be understood in such 25 a way that when reaching a distance  $d = 0$ , host vehicle 12 has been decelerated to a travel velocity  $V0$  which is equal to velocity  $V1$  of preceding vehicle 13. In this case, vehicle 12 would touch vehicle 13, without, however, allowing an application of force to occur. If one now calculates that at time  $t = tR + tB$ , 30 at which velocity  $V0$  of host vehicle 12 is equal to velocity  $V1$

of preceding vehicle 13 and there is a distance  $d > 0$ , then one can already predict at time  $t = 0$  that a collision is avoidable and no driver warning is issued. If one calculates in advance that at time  $t = tR + tB$  at which host vehicle 12 has velocity  $v_0$ , which 5 is equal to velocity  $v_1$  of preceding vehicle 13, and that there is a distance  $d = 0$  or  $d < 0$ , then one can predict already at time  $t = 0$  that a collision cannot be avoided by a strong deceleration intervention in vehicle 12 and the driver of vehicle 12 must be warned about this in accordance with the present invention. This 10 occurs by issuing a driver warning to warning devices 9, 10, 11. Thus, at every computation point it is assumed that preceding vehicle 13 could initiate a deceleration  $a_1$  and a braking scenario is precalculated for this purpose in which the driver's reaction time  $tR$ , the magnitude of the deceleration  $a_2$  of host vehicle 12, 15 the distance  $d$  between the vehicles, the relative velocity  $v_{rel}$  of the preceding vehicle 13 with respect to host vehicle 12 and the host vehicle's velocity  $v_0$  are ascertained, and this is used to calculate whether a collision would be avoidable or whether it must occur. Accordingly, the driver is warned and advised to 20 increase his distance  $d$  or to reduce his own vehicle velocity  $v_0$  so as to be able to brake in time in the event that preceding vehicle 13 triggers a deceleration.

~~Abstract~~ABSTRACT

A method and a device for warning the driver of a motor vehicle  
are provided, an. An object detector being is provided, which  
5 detects preceding vehicles and ascertains their distance and  
relative velocity with respect to the host vehicle and supplies  
these to an evaluation device. The evaluation device (1) assumes  
that the preceding vehicle (13) would perform a deceleration ( $a_x < 0$ )  
and ascertains as a further function of the variables measured by  
10 the object detector and the driver's reaction time and the host  
vehicle's maximum possible deceleration whether a collision with  
the preceding vehicle would be avoidable. If an unavoidability of  
a collision is recognized, then a driver warning device is  
activated.

15

(Figure 2)